

University of Nebraska - Lincoln

DigitalCommons@University of Nebraska - Lincoln

CSE Conference and Workshop Papers

Computer Science and Engineering, Department of

2012

Poster Abstract: Crane Charades: Behavior Identification via Backpack Mounted Sensor Platforms

William P. Bennett

University of Nebraska-Lincoln, wbennett@cse.unl.edu

Megan Fitzpatrick

University of Wisconsin-Madison

David Anthony

University of Nebraska-Lincoln, danthony@cse.unl.edu

Mehmet C. Vuran

University of Nebraska-Lincoln, mcvuran@cse.unl.edu

Anne Lacy

International Crane Foundation

Follow this and additional works at: <http://digitalcommons.unl.edu/cseconfwork>

Bennett, William P.; Fitzpatrick, Megan; Anthony, David; Vuran, Mehmet C.; and Lacy, Anne, "Poster Abstract: Crane Charades: Behavior Identification via Backpack Mounted Sensor Platforms" (2012). *CSE Conference and Workshop Papers*. 289.

<http://digitalcommons.unl.edu/cseconfwork/289>

This Article is brought to you for free and open access by the Computer Science and Engineering, Department of at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in CSE Conference and Workshop Papers by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.

Poster Abstract: Crane Charades: Behavior Identification via Backpack Mounted Sensor Platforms

William P. Bennett, Jr.[†] Megan Fitzpatrick^{††} David Anthony[†] Mehmet C. Vuran[†] Anne Lacy[‡]
[†]CPN Laboratory, Computer Science and Engineering, University of Nebraska-Lincoln, Lincoln, NE
{wbennett,danthonymc,vuran}@cse.unl.edu
^{††}Zoology Department, University of Wisconsin-Madison, Madison, WI
mjfitzpatric@wisc.edu
[‡]International Crane Foundation, Baraboo, WI
anne@savingcranes.org

ABSTRACT

The Whooping Crane is an endangered species native to North America and there are approximately 575 in existence. There have been recent efforts to provide ecologists with a tool to study the multifaceted behavior of the endangered species. Like many species, cranes display distinctly identifiable movements while being threatened, acting territorial, migrating, or preening. The preliminary experiments described in this poster provide evidence that sensor data presented by a novel sensing platform, the CraneTracker, can be used to identify crane behaviors on-board. With the ability to identify these behaviors, ecologists will have a more granular insight on what occurs during a crane's life on a daily basis.

Categories and Subject Descriptors

C.2.1 [Computer-Communication Networks]: Wireless communication

General Terms

Experimentation

Keywords

Wireless sensor networks, tracking, behavior identification

1. INTRODUCTION AND MOTIVATION

The Whooping Crane (*Grus americana*) is one of the most endangered species native to North America. Of the 575 in existence, 279 are from the original migratory Aransas-Wood Buffalo population (AWBP). These birds conduct a 4,000km annual migration from southern Texas to northern Canada, often flying 950 km/day during migration. The other portion of the cranes exist in captivity or re-introduced in Wisconsin, Florida, and Louisiana.

Recently, conservation efforts have centered on utilizing new tracking and monitoring technology to assist researchers in answering concerns regarding the newly re-introduced population in WI. The data collected from these efforts is intended to reveal potential causes of mortality, inability to reproduce in the wild, and possible impact a human dominated landscape on these birds.

Presently, Whooping Cranes' inability to reproduce is the most pressing threat to the success of the reintroduction efforts. There are several explanations for these problems. First, it has been suggested that black-flies in the breeding grounds in Canada may be harassing birds, forcing them to flee from their nests. Second, the birds may be physically unable to complete incubation due to the lack of energy resources. They are compelled to leave their eggs to find food resources away from their territory.

The cranes exhibit distinct movements related to the behaviors they are engaging in. These behaviors are typically broken into comfort, locomotion, foraging, and social behaviors. These behaviors can be identified using state-of-the-art sensors, while recording time and location. The frequency of behaviors occurring or lack thereof, could be used to flag irregular behavior. Using MEMS sensors, there has been studies to identify animal behavior [3-6], which rely on data loggers [6]. Consequently, the studies rely on the recovery of devices to extract information. The improbable chance of crane recapture, high device energy consumption and lack of wireless data recovery make these tools unsuitable for monitoring Whooping Cranes. Instead, ecologists rely on direct observations, a task that is often difficult in field conditions.

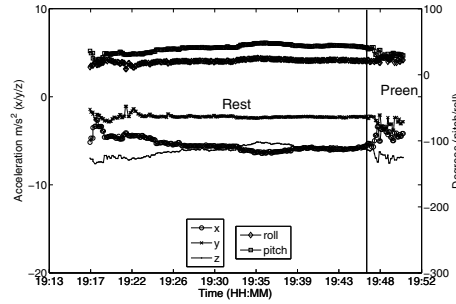
In our recent work, we have developed the CraneTracker platform [1], which provides a rich set of sensors coupled with multi-modal communication to satisfy the data requirements of ecologists. Deployments with captive and wild cranes have provided measurements that never existed before for crane monitoring. Moreover, the deployed platforms have successfully survived 5 months of operation and a migration of 1,725 km. In this work, we discuss the preliminary data collected on captive birds that provide evidence that the basic movements can be classified on-board using the developed Crane Tracker platform [1].

2. EXPERIMENT RESULTS

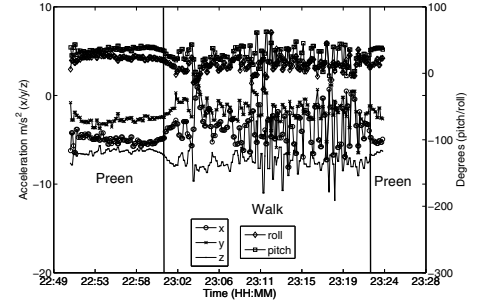
To exploit the behavioral sensing capability of the CraneTracker platform [1], a set of controlled experiments were carried out at the International Crane Foundation, Baraboo, Wisconsin in July 2011. For the experiments, a tracker was programmed to collect solid-state compass readings at a sampling rate of 10 Hz for 30 seconds every 3 minutes. The readings from this sensor consist of acceleration in three axes, heading, pitch, roll and ambient temperature. To ensure their safety, crane were handled by experienced ecologists. The tracker was harnessed to a crane as a backpack and monitored over a closed circuit camera Fig. 1(a). The



(a)



(b)



(c)

Figure 1: (a) CraneTracker on captive Siberian Crane (top), close-up view (bottom). Behavioral movements (b) rest to preen and (c) preen to walk to preen.

data were transmitted using the Zigbee radio interface to a base station, which was equipped with a directional antenna. The goal of the experiments was to correlate well-known crane behaviors with the solid-state compass readings. The behaviors from the camera feed were corroborated by an ecologist.

Data from the compass were collected over 4 hours and 21,882 records were received. In post processing, the video recording was played in sync with and the plotted data was annotated at points where basic behavior changed. In Figs. 1(b) and 1(c), the tri-axial acceleration (m/s^2) noted on the left y-axis and orientation (pitch/roll in degrees) noted on the right y-axis, are plotted over time. In the burst depicted in Fig. 1(b), the crane begins in a resting behavior then at 19 : 47 changes to a preening behavior. In Fig. 1(c), the crane is preening, then at time 23 : 00 starts to walk around the cage, and then at 23 : 22 returns back to preening behavior. The collected data supports that distinct behaviors can be differentiated.

3. FUTURE WORK

In the future, our goal is to identify cranes' behavior using the on-board processing capabilities of the CraneTracker, instead of logging an immense amount of data for post processing. The experiment results shown in Figs. 1(b) and 1(c) motivate the feasibility of this approach. Moreover, our initial work shown in a demonstration [2], proves that processing behavior on the mote is possible. The next steps in this process includes constructing a behavioral model, that correctly identifies common behaviors and obscure behaviors from sensor readings with great probability. The development of this model will require more experiments with captive and free-living cranes, over longer sensing periods.

Effective on-board processing enabled by this model, will be beneficial by reducing data stored and transmitted during sensing missions. In addition, the reduction of data transmitted could save a considerable amount of energy, extend sensing mission life-time, and more importantly, be more effective in the conservation of Whooping Cranes.

4. REFERENCES

- [1] D. Anthony and et. al., "Sensing through the continent: Towards monitoring migratory birds using cellular sensor networks," in *Proc. ACM/IEEE IPSN '12*, Beijing China, April 2012.
- [2] W. Bennett and et. al., "Cranetracker: A multi-modal platform for monitoring migratory birds on a continental scale." in *ACM MobiCom '10 Demo*, Las Vegas, NV, September 2011.
- [3] A. Gleiss and et. al., "Making overall dynamic body acceleration work: on the theory of acceleration as a proxy for energy expenditure," *British Ecological Society, Methods in Ecology and Evolution*, vol. 2, pp. 23–33, Aug. 2011.
- [4] E. Shepard and et al., "Identification of animal movement patterns using tri-axial accelerometry," *Endangered Species Research*, vol. 10, pp. 47–60, March 2008.
- [5] R. Wilson and et al., "Moving towards acceleration for estimates of activity-specific metabolic rate in free-living animals: the case of the cormorant," *British Ecological Society, Journal of Animal Ecology*, vol. 75, pp. 1081–1090, Sept. 2006.
- [6] —, "Prying into the intimate details of animal lives: use of a daily diary on animals," *Endangered Species Research*, vol. 4, pp. 123–137, Jan. 2008.